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Original Research

Culture results of lumbar puncture samples in the emergency ward: A descriptive study

Lumbar puncture culture results

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Abstract
Aim: This study aimed to present diagnostic procedures in patients admitted to an emergency department who underwent lumbar puncture (LP) due to suspected bacterial meningitis.
Material and Methods: The study included patients admitted to the emergency department between 01 January 2013 and 31 December 2015. Patients who underwent lumbar puncture with a differential diagnosis of acute bacterial meningitis (ABM) were included in the study. The hospital patient registry was searched for the procedure "Spinal tap" in the emergency room (ER).
Results: Of the 412 patients, 50.5% (n=208) were children aged <9 years. The median age was 9 years, ranging from 0 to 93. The sex distribution was as follows: 183 (44.4%) females and 229 (55.6%) males. Of the 875 112 admissions to the ER, 412 (4.7 per 1000) underwent a spinal tap due to suspected ABM. A seasonal variation was observed in the number of applications with November and December having the maximum frequencies. In 297 (72.1%) cerebrospinal fluid (CSF) samples, bacterial infection was suspected. Of the 381 samples (92.4%) sent for culture, 10.0% (n=41) were positive. The most commonly encountered pathogens were S. aureus and skin flora (both 56.1%, n=23). Computed tomography investigation was prescribed before the LP procedure to 276 patients (67.0%).
Discussion: Turkey should introduce clear policies in managing patients requiring spinal taps in the emergency wards, including the conditions to prevent contamination and ordering computed tomography. Necessary training should be planned for the hospital staff from these perspectives.

Keywords
Lumbar Puncture, Bacterial Meningitis, Cerebrospinal Fluid, Emergency Room

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Introduction

Background/rationale

Meningitis is an infectious disease characterized by infection of leptomeninges and underlying subarachnoid cerebrospinal fluid (CSF). Meningitis is the most common cause death frominfectious diseases. It is estimated that one million cases of bacterial meningitis occur each year worldwide, of which 200,000 die Case fatality rates vary with age at the time of illness and the species of bacterium causing infection. The mortality range is 3%–19% in developed countries and 37%–60% in developing countries. Up to 54% of survivors remain disabled due to bacterial meningitis [1].

Acute meningitis is a clinical condition in which meningeal symptoms occur within hours or days. Chronic meningitis, on the other hand, may take weeks. Headache is usually the earliest symptom, followed by confusion or coma [2]. The etiological distribution of meningitis varies considerably depending on age, geographical differences, season, sensitivity to certain factors, genetic structure, socioeconomic conditions, and local endemic factors [3]. In spite of the advances in diagnosis and antimicrobial therapy, meningitis continues to be one of the important causes of permanent sequelae in humans [4].

The main purpose in a patient with meningitis is to diagnose and start effective treatment as soon as possible. Immediate empirical antimicrobial therapy should be initiated after the CSF culture sample is taken, and then appropriate treatment should be performed according to the clinical and laboratory findings [3,5]. Thus, interventions in the emergency ward and the reliability of the diagnostic procedures are of utmost importance.

Objectives

We hypothesized that the proportion of spinal taps ordered in our hospital and their results are similar to the literature. This study aimed to present diagnostic procedures in patients admitted to the emergency department who underwent lumbar puncture (LP) due to suspected bacterial meningitis.

Material and Methods

Study design

The study was conducted in a cross-sectional plan. Study reporting was done following the STROBE guidelines [6]. The research protocol was approved by the Local Ethics Committee at Marmara University Medical Faculty (IRB number: 09.2015.260; Date: 02 October 2015).

Setting

The investigation was performed at the Emergency Wards of the Marmara University Pendik Education and Research Hospital during January 2016. The study hospital is a tertiary care health center in Istanbul with 600 inpatient bed capacity. The emergency department welcomes annually around 300 000 patients (http://actad.tip.marmara.edu.tr/genel-bilgiler/).

Participants

The study comprised patients admitted to the emergency department between 01 January 2013 and 31 December 2015. Patients who underwent lumbar puncture with a differential diagnosis of acute bacterial meningitis (ABM) were included in the study. The hospital patient registry was searched for the procedure "Spinal tap" in the emergency room (ER). Patients who underwent lumbar puncture due to reasons other than suspected bacterial meningitis (subarachnoid hemorrhage, central nervous system malignancies, demyelinating diseases, Guillain-Barré syndrome) were excluded from the study. Data from 412 patients were analyzed (Figure 1).

Variables

The study data were obtained from the hospital's electronic medical records. The primary outcome variable of the study was culture positivity. The secondary outcome was the type of the pathogens grown in the culture. Other variables studied were age, sex, study date, computed tomography (CT) investigation before LP, and duration of hospitalization.

Bias

To prevent bias, data was collected by one researcher and approved by another investigator. Additionally, error checking and debugging were made after entering data into the computer.

Study size

The required sample size was calculated based on a 10.5% expected positivity in the CSF cultures. Given an unknown population and a margin of error of 3%, a sample size of 402 cases is required to estimate positive cultures in the study population with a confidence interval of 95%.

Statistical methods

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 25.0 software (SPSS Inc., Chicago, IL, USA). The results were presented as frequencies, percentages, means, and standard deviations (SD). The Kolmogorov–Smirnov test was performed to test if the numerical variables were normally distributed. The independent samples t-test or One-way ANOVA was used to compare data meeting parametric assumptions. The Mann-Whitney U or Kruskal-Wallis tests were used for skewed variables, and the Chi-Square test was used for categorical variables. A p value of <0.05 was considered statistically significant.

Ethical Approval

Ethics Committee approval for the study was obtained.

Results

Participants

Of the 412 patients, 50.5% (n=208) were children aged <9 years, 12.6% (n=52) were adolescents (age 10-19 years), 26.5% (n=109) were adults (age 20-64), and 10.4% (n=43) were elderlies (>64 years). Their median age was 9 years, ranging from 0 to 93. The sex distribution was 183 (44.4%) females / 229 (55.6%) males.

Descriptive data

Of the 875 112 admissions to the ER, 412 (4.7 per 1000) underwent a spinal tap due to suspected ABM. The number of applications ranged from 22 to 52 per month, with November and December having the maximum frequencies (Figure 2).

Outcome data

All patients underwent a direct microscopic investigation of the CSF; 297 (72.1%) of the samples were suspected of bacterial infection. However, 381 (92.4%) of the CSF samples were sent for culture. Of the samples sent for culture, 10.0% (n=41) were positive. Only one pathogen could be isolated from most of the samples. Nevertheless, two agents were grown from 11 samples (26.8%), and three pathogens grew in one case (2.4%). The distributions of the pathogens grown are seen in Table 1. Culture positivity was 11.2% (n=19) among females and 10.4% (n=22) among males; the difference was not statistically significant (Chi-Square=0.073; p=0.787). Additionally, a computed tomography investigation was prescribed before the LP procedure to 276 patients (67.0%).

The median duration of hospitalization was 2 days (min. 1, max. 72 days). Patients with S. aureus and H. influenza grown had significantly longer hospitalization times compared to others (Table 2). There was no difference between the age groups concerning the duration of hospitalization (F=0.210; p=0.890). Also, no difference was found between sex and length of hospitalization (Z=1.742; p=0.082).

Figure 1. Study participant flow diagram.

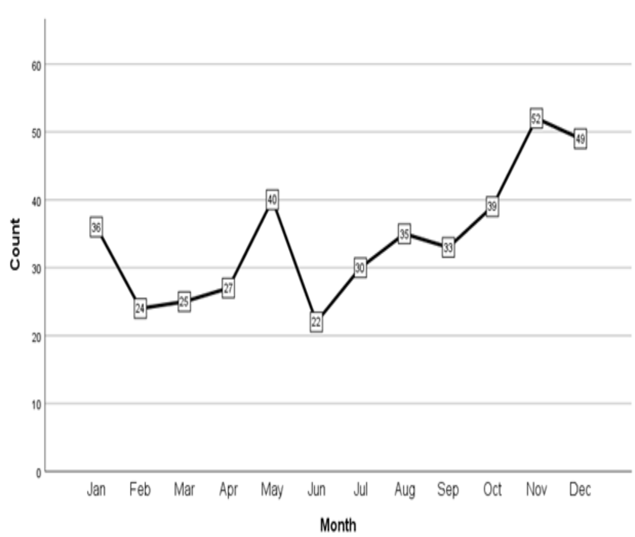

Figure 2. Distribution of the applications according to the months of the year.

Table 1. Distribution of the bacteriological analysis results of the CSF samples.

	n	%
Direct microscopy		
Negative	115	27.9
Positive	297	72.1
Culture		
Negative	340	82.5
Positive	41	10.0
Number of agents grown		
One agent	29	70.7
Two agents	11	26.8
Three agents	1	2.4
Pathogens grown		
Staphylococcus spp	23	56.1
Skin flora	23	56.1
Streptococcus pneumoniae	4	9.8
Haemophilus influenza	3	7.3
Neisseria meningitidis	1	2.4

Table 2. Comparison of bacteriological analysis results and duration of hospitalization.

		Hospitalization			p
		Mean	SD	t/Z/F	
Culture	Negative (n=328)	5,12	7,34	1.688*	0.098
	Positive (n=41)	7,54	8,56		
Skin flora	Negative	5,23	7,24	1.487#	0.151
	Positive	8,19	8,95		
S. pneumonia	Negative (n=392	5,41	7,38	-0.516#	0.606
	Positive (n=4)	3,5	3		
H. influenza	Negative (n=393)	5,42	7,37	-7.509*	<0.001
	Positive (n=3)	1,67	0,58		
N. meningitides	Negative (n=395)	5,4	7,36	-0.461#	0.645
	Positive (n=1)	2	.		
S. aureus	Negative (n=374)	5,14	7,14	2.111*	0.046
	Positive (n=22)	9,55	9,62		
Number of agents grown in cultured	0 (n=357)	5,15	7,18	2.547**	0.08
	1 (n=28)	6,68	7,96		
	>1 (n=11)	9,73	10,01		

#: Student t-test; *: Mann-Whitney U-test; **One-way ANOVA.

Discussion

Key results

Applications to the emergency service (ER) ending in lumbar puncture ranged from 22 to 52 per month. The highest frequencies were observed in November and December. In the ER, a spinal tap was performed at a rate of 4.7 per 1000 patients. Direct microscopic examination was performed to all CSF samples, and 92.4% were sent for culture. 10.0% of the culture results returned positive. A single pathogen was isolated from most samples. However, 29.2% of the samples had more than one pathogen grown.

Interpretation

Köse et al. [7] reported a mean age of 45 among adult ABM patients with a male/female distribution of 54.3%/47.8%. In the study conducted by Erdem et al., the mean age of patients diagnosed with ABM over age 50 was found 63 years [8]. Studies on pediatric patients in Turkey reported the median age as 3.5 with a boy/girl ratio of 1.29:1 [9] and a mean age of 4.74 with an equal male/female ratio [10].

It has been already proven that bacterial meningitis has a seasonal pattern. Countries in the African meningitis belt, for example, are known for peak incidence during the dry season. A persistent seasonality was detected in 96% of the 51 time-series from 38 countries, demonstrating a seasonal peak during the winter months in both hemispheres [11]. It was hypothesized that there is a potential relationship between climate and the seasonality of bacterial meningitis across a broad geographic range [12]. We agree with the postulation that climatic conditions may facilitate pathogen invasion by damaging the nasopharyngeal mucosa [13].

The final diagnosis of ABM is made by CSF culture. Bacterial growth in culture medium was reported as 60-80% [14]. In Turkey, causative agents could be isolated from cultures ranging from 38.6% [18], 45.4% [10] to 92.5% [11]. In a retrospective study by Ghotaslou et al. [15] from Iran, the most frequent etiologic pathogens of ABM were reported as S. pneumoniae, H. influenzae, Enterobacter spp, and N. meningitidis. In the retrospective study from Greece, covering the years 1974 to 2005 in the pediatric age group, N. meningitidis ranked first among all age groups throughout the years, whereas unspecific bacteria (Streptococcus spp, Enterobacter spp, Salmonella spp., and Rickettsiae spp) and H. influenzae, S. pneumoniae were included in the etiology of ABM as other causative pathogens [16].

When we look at the distribution of pathogens in our patients with CSF culture, Staphylococcus spp was the most common species. The Staphylococcus spp. infection colonizes the mucosa and skin, causes a wide range of skin and soft tissue infections, bacteremia, infective endocarditis, osteomyelitis, splenic abscesses, sepsis, and septic shock in patients having prosthetic valves or being immune compromised [17]. As a cause for ABM, Staphylococcus spp. is frequently encountered after head trauma and neurosurgical operations, and less frequently secondary to bacteremia [18]. In our study, Staphylococcus spp. and skin flora were the most frequently grown bacteria in the CSF cultures. Keeping in mind that this result has a negative impact of the patients and the culture outcomes, we may conclude that the study hospital has unsuitable conditions for lumbar puncture and that the spinal tap procedures are performed in insufficiently sterile conditions.

In a study performed by Arda et al. [19], the frequency of agents causing ABM in decreasing order was determined as S. pneumoniae, N. meningitidis, and Staphylococcus aureus. In another study by Erdem et al. [8] in adult patients over 50 years of age, the causative pathogens were mentioned as S. pneumoniae, Listeria monocytogenes, and Staphylococcus epidermidis. On the other hand, in the study of Köse et al. [7], the following frequencies were reported: S. pneumoniae, Acinetobacter spp, and Listeria monocytogenes.

In studies performed in Turkey among pediatric patient groups, the most common pathogens were N. meningitidis followed by S. Pneumoniae; Haemophilus influenzae type B was not observed in any patient [9]. After the ceftriaxone molecules were introduced to Turkey in 1988, the prevalence of S. pneumoniae, a highly resistant bacteria to penicillin, started to decrease [20]. Furthermore, between 1974 and 1986, 295 patients were diagnosed with ABM, and in 76.4% of these patients, N. meningitidis was the causative pathogen; a majority of the cases were reported from military units. The incidence of ABM due to N. meningitidis ceased after 1995, with the introduction of routine vaccination in the military units [21].

In this study, 276 patients (67.0%) underwent cranial CT imaging before LP. However, the CT scan time is accused of prolonging the LP procedure and delaying the diagnosis and antibiotic initiation [22]. A prospective study of 307 cases by Hasbun et al. [23] reported that CT scan causes a 2-hours delay in diagnosing ABM and one-hour delay in starting treatment. In 2009, Sweden revised its guidelines and removed cranial CT from the list of initial tests to be performed in impaired mental status [24]. This policy change shortened the duration of IV antibiotic treatment by approximately 1-2 hours and resulted in a 7-12% reduction in mortality. Besides, the European Society of Clinical Microbiology and Infectious Diseases (ESCMID) published in 2016 [25] recommends cranial CT before lumbar puncture in the following conditions: Glasgow Coma Scale (GCS) <10, presence of focal neurological deficits (except cranial nerve palsy), presence of a recently developed seizure, severe mental state deterioration, and severely impaired immune system. We believe that Turkey requires an urgent policy change from the perspective of correctly utilizing CT investigations.

Limitations

Study data collection was based on the hospital's electronic patient registry. Thus, we could not obtain information on the basis of which the doctors came to the diagnosis of ABM. Likewise, we could not retrieve the exact count of spinal tap indications. More reliable and less missing data could be obtained if the data were collected directly on-site. However, given the long duration of the study period, this was not feasible.

Conclusion

ABM is an infectious disease with high morbidity and mortality requiring early diagnosis and treatment. Therefore, meningeal irritation findings should be investigated in patients presenting with headache, fever, nausea, vomiting, and change of consciousness. Our study demonstrated that despite the relatively high number of lumbar punctures performed in the hospital the proportion of positive findings was comparatively low. There were clues suggesting that lumbar punctures under emergency service conditions were not performed under sterile conditions. Turkey should introduce clear policies in managing patients requiring spinal taps in the emergency wards, including requirements to prevent contamination and ordering computed tomography. Necessary trainings should be planned for the hospital staff from these perspectives.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with *the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.*

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Conflict of interest
The authors declare no conflict of interest.

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